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AGRICULTURAL MEMORANDUM NO 675

WEATHER CONDITIONS FOR CROP SPRAYING I

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1. Background

A commercial spraying concern, extending its operations northward into the East Riding of Yorkshire, encountered difficulties. It was found that spray timings used farther south were sometimes not effective here and that scheduled work was not always completed in time. It was decided to assess the hours available for spraying, month by month.

2. Conditions for spraying

This note is concerned with the use of hormone materials such as 2,4-D, commonly used for the control of broad-leaved weeds. For these to be effective, at least three weather conditions must be satisfied simultaneously. It was decided at the outset that this would make it necessary to use computer analysis of observations obtained for weather forecasting purposes. The conditions acceptable for spraying were therefore framed with an eye to the available programs and data in machinable form.

a. Wind:

Strong winds bring the danger of spray drift onto adjacent susceptible crops. Even where this is not a hazard, mechanical damage to leaves may occur, sufficient to allow unacceptable amounts of herbicide to penetrate into the crop plants. It was suggested that the wind should be less than 5 mph at the spraying height of 21 inches (53 cm) over a crop 3 - 6 inches ($7\frac{1}{2}$ - 15 cm) in height. On airfields the wind is measured at a height of 10m above the ground. Applying the usual logarithmic variation of wind with height, with a roughness length equal to 1/10 the height of the vegetation roughness elements, gave a limit of 8 knots at anemometer height.

b. Precipitation:

Rain will dilute the spray, or even wash it off the foliage entirely. Occasions with any form of precipitation at the time of observation (present weather codes 50 -99) were excluded, and so were those with precipitation during the past hour (codes 20 - 29). For best effect, there should be no rain for six hours after spraying. At present, this condition cannot be included in the computer program (nor indeed can it be foreseen with certainty at the time of deciding to spray) and it was not included in the analysis.

c. Temperature:

For rapid absorption of the hormone, the temperature should be above 50°F (10°C). When the temperature is 45° - 50°F (7.2° - 10°C) it works, but with reduced efficiency. Below 45°F the material is ineffective. For present purposes the three temperature ranges are called "fit", "cool" and "cold" respectively.

Sometimes the temperature, although not high enough for effective action at spraying time, becomes so later in the day. This contingency has been allowed for and is mentioned again later.

d. Visibility and State of Ground:

These two parameters were included in the analysis at first. Visibility was required to be greater than 200 yards, because it was known that occasional inaccuracies in spraying had occurred when the opposite side of the field could not be seen. The state of ground was required to be "dry" or "moist" ie without standing water or any cover of snow or ice.

In practice, at the site considered, these restrictions complicated the analysis considerably but eliminated very few occasions. In particular the occasions of "ground unfit" (mostly in March) were practically all also ruled out by low temperature. They will not be mentioned further.

3. The data

Only two stations in the East Riding were available for analysis. The one chosen was Leconfield, an airfield near Beverley. The period was 1960 - 67. Full synoptic observations every three hours round the clock (03, 06 etc GMT) were available on magnetic tape.

4. The Analysis

The computer sorted the observations according to the criteria listed in section 2 above. Tables were produced not only of occasions fit for spraying, but for all combinations of parameters acceptable and unacceptable, making it possible to study the reasons for rejection. Since some hours were rejected for more than one reason (say, too windy and too cold) it is difficult to present the mass of information in assimilable form.

The procedure adopted (see the figures) was to start with a vertical block representing 100% of the observations at a particular hour. From this were eliminated successively, those that were too windy (but dry), those that were windy and wet, and those that were merely wet. Those remaining were divided on temperature into "cold", "cool" and "fit", as defined in section 2c.

5. Discussion

The most marked feature of the results is the small proportion of /

hours available for spraying, seldom exceeding 25%, and often much less. It seems likely that much commercial spraying is done in far from ideal conditions. Wind is the dominating factor, followed by temperature. On fine mornings, the wind speed usually rises steadily from low values, and so does the temperature in a rather different fashion. The question is whether, by the time the temperature has risen to an acceptable level, the wind speed will still be within limits. In early spring, temperature is often limiting, in mid-summer, much less so; and in April and May the position is intermediate and there is a delicate balance between temperature and wind considerations.

It was mentioned in section 2c, that early morning spraying may sometimes be done effectively at low wind speeds and low temperatures, provided that temperatures become acceptable later. This applies to material like 2,4-D but not to more volatile compounds. On average temperatures rise from the midday value to a maximum around 14GMT, declining to the 12GMT value again by around 16GMT. It is therefore assumed that if the temperature is fit for spraying at 12, it will stay so for some four hours in the afternoon, which is sufficient for the herbicide to act. The morning hours acceptable on wind and weather have therefore been re-divided according to the temperature at midday, the new categories being called "cold day", "cool day" and "fit day". This procedure, if it can be accepted, gives a marked increase in the morning hours available for spraying, particularly in April and May. In the figures this redistribution is shown by a block for the morning hours to the left of the main histograms.

6. Strong convection - a warning

Occasionally very light surface winds occur in combination with strong heating of the ground surface by the sun. Then small spray droplets may be carried upwards in organised convection cells, and drift erratically for some distance without much dilution, before being deposited on other crops. In this note no estimate has been made of the frequency of such conditions, but some of the worst cases of crop damage have been associated with them.

7. Future work

It is hoped to extend this work to other area and times of year. It is particularly requested that interested readers should let the author know if they think that the criteria adopted for spraying weather are realistic, or whether they could be improved. He would also be glad to have other comments and suggestions.

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/ figures overleaf

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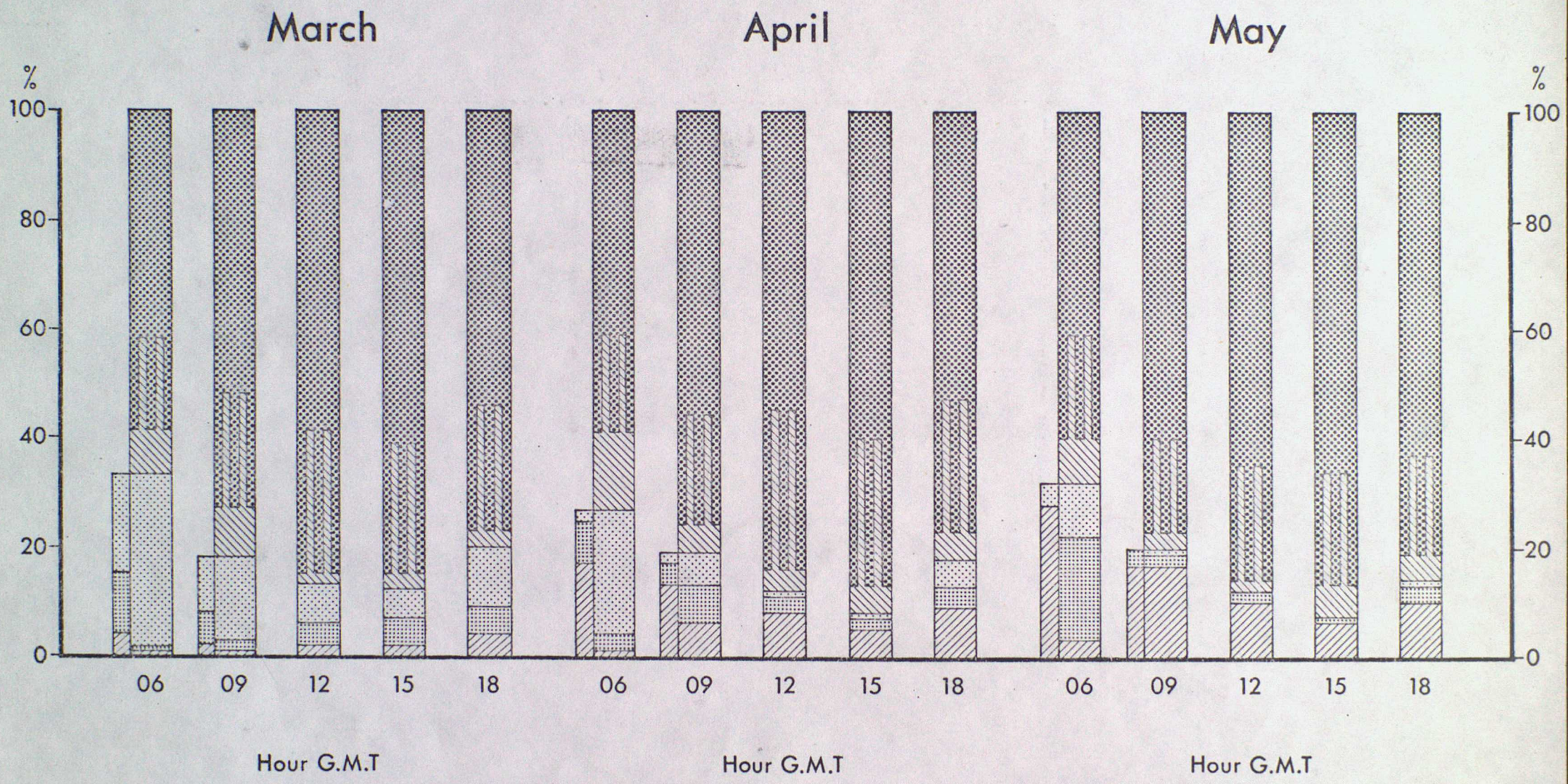
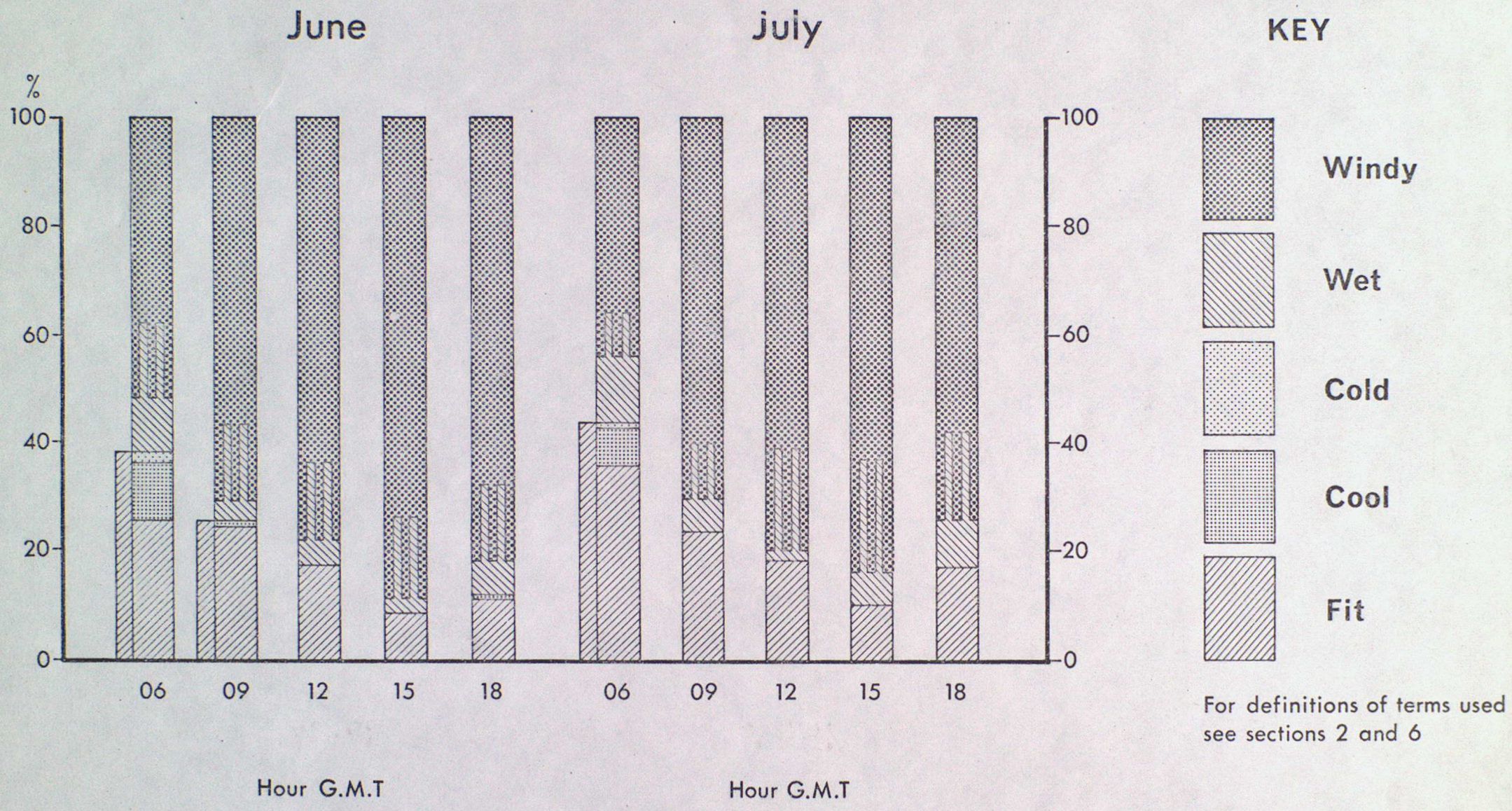
Occurrence of different conditions for crop spraying at Leconfield




June
July
KEY
%
100
80
60
40
20
0
06
09
12
15
18
Hour G.M.T
Windy
Wet
Cold
Cool
Fit
For definitions of terms used see sections 2 and 6